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Plate 1.



PYROTECHNY;

OR

COMPLETE DIRECTIONS

FOR

MAKING AND MANAGING

Artificial Fireworks.

PARTICULARLY

Sky Rockets,
Swarmers,
Girandoles,
Line Rockets,
Water Rockets,
Water Brands,
Water Cats,
Water Ducks,
Water Crackers,
Rocket Flyers,
Fire Wheels,
Cartouches,

Fire Tubes,
Leaping Fire Globes,
Light Balls,
Water Globes,
Serpents,
Crackers,
Fire Launces,
Saucissons,
Fire Pots,
Thunder Powder,
Artificial Earthquakes,
Burning Letters and Names,

the

Chinefe Method of embellishing Fireworks with Flowers, &c.

With a Variety of other Curious Information.



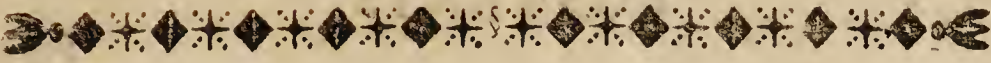
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PREFACE.

THE Art of making Fire-works being but little known except to few persons, and bosks upon that subject being extremely rare and valuable, the Editor of the following sheets flatters himself they will not be unacceptable to those who have a partiality for such amusements, and opportunities of attending to them.

In all public rejoicings, Fireworks have hitherto been indispensible; and although many mischievous and hurtful consequences have arisen from the ill management of them, yet, when conducted with prudence, they afford, though a transient, yet a beautiful and interesting spectacle.

Sky Rockets being the principal objects in those exhibitions, a larger portion is allotted to that article; in which will be found the most complete directions for their formation. The charges are proportioned with the greatest accuracy; and, if properly managed, the effect will be found to answer the highest expectation.

Several of the other articles are of French invention; and being but little known in England, they cannot fail of being acceptable. A little practice, and attention to the rules set forth, will very soon render them easy and familiar.

CONTENTS.

	Page
To make Sky Rockets	5
To prepare Cafes for Swarms	6
To prepare the Charges for Rockets, and order the Fires thereof to be of various Colours	8
To bore the Rockets	13
Garnishing of Rockets	ibid.
How to proportion the Rocket Poles and Sticks	14
Rockets without Sticks	15
Of Girandole Chests	ibid.
Of Line Rockets	16
To join two Rockets to one another; the one to burn in the Water, and the other to fly into the Air	18
To make Water Rockets, Water Brands, Water Cats, Water Ducks, &c.	19
Some General Remarks upon Rockets	23
Defective Rockets, how discovered	ibid.
Of Rocket Flyers, and the Manner of charging them	24
Of Fire Wheels	25
To make fingle and double Cartouches	29
Of Fire Tubes	31
Of fingle Tubes or Cafes	33
A Prefervative for Wood againſt Fire	ibid.
To prepare a Globe which burns like a Star, and leaps about both on Land and Water	34
To prepare Light Balls	ibid.
To prepare Paſte for Stars and Sparks	35
To prepare Water Globes with fingle or double aſcending Rockets	ibid.
Manner of preparing Melted Stuff	37
To make a Serpent	38
To make a Fire Lance	39
To make a Saucifſon	40
To make Fire Pots	42
To make Thunder Powder	ibid.
To make an artificial Earthquake	43
To produce Exploſion imitating Gunpowder	ibid.
To imitate Thunder	ibid.
Manner of preparing Burning Letters and Names for Illuminations	ibid.
Charges for Burning Letters with Cafes	45
Manner of making Fire burn of a green Colour	ibid.
To make Torchés which cannot be extinguished by either Wind or Rain	ibid.
To make a Cracker	ibid.
Odoriferous, or perfumed Water Balls	46
Wildfire which burns under Water	ibid.
Chineſe Method of embellishing Fireworks with Flowers, &c.	ibid.

THE
ART

OF

MAKING FIRE-WORKS.

To make Sky-rockets.

ROCKETS bearing the pre-eminence among fire-works, it is requisite to give some definition of every part of them; how they are made, finished, and fired. In order to do this, I shall first endeavour to give the curious some idea concerning the moulds they are formed in. These are turned usually of close and hard wood. Some are made of ivory; and for rockets of extraordinary large sizes, they are cast in brass or copper, and turned the inside in a nice manner, the foot or basis with its cylinder; wart, or half-bullet, may in these, as in others, remain of solid wood. The whole is commonly turned in the size and form of a column in architecture, and embellished with ornaments according to fancy.

*The order to be observed in the size of the cylinder.—*It is agreed by the most famous artificers, that the moulds of all rockets, from a half to six pounds, ought to be six diameters; but the larger size of four, four and a half, or five diameters of their orifices high.

Those rockets which go under the denomination of small ones, are those whose inward diameter cannot receive a ball that exceeds one pound. The middling sort are those whose diameter can admit balls of one, two, or three pounds; and great ones are such whose bore will receive balls from three to 100 pounds.

Rocket-moulds, from some ounces to 3 pounds, are ordinarily seven diameters of their bore long, the foot two or three diameters thick, the wart two-thirds of the diameter, and the piercer one-third of the bore; the roller two-thirds, and always one or two diameters from the handle longer than the mould; the rammer one diameter shorter than the mould, and somewhat thinner than the roller, to prevent the sacking of the paper when the charge is rammed in; having always one still shorter, that when the shell of the rocket is rammed half full, you may use that with more ease. For the better illustration (see fig. 1.), representing the mould with its basis, cylinder, bore, and piercer. A B the interior diameter of the mould; C D the height of the mould, seven diameters; from D to E is the height of the breech at bottom, which stops the mould when the rocket is driving; and this is one and a third diameter. Upon this bottom you have a solid cylinder, whose height is one diameter of the orifice A B. This cylinder is crowned with a wart or half bullet I, having a hole in the centre, in which is fixed the iron or copper piercer F.—G, an iron pin that keeps the bottom and cylinder together. 2. The roller. 3. The rammer. 4. The shorter rammer.

It is to be observed, that some of these moulds are made nine diameters of their orifice long; the shell, therefore, with the wart, will be twelve diameters. These sorts of rockets fly very high, because of their length, they containing a greater charge than the short. Nevertheless, the piercer needs to be no longer than seven diameters, but substantial, so as to keep in its proper attitude. It will require the dimensions of two-thirds of the diameter at bottom, and from thence tapering to half the diameter.

How to prepare Cases for Swarmers or Rockets.

THE cases or trunks of rockets are made of dif-

ferent sorts of things, namely, of paper, wood, tin, pasteboard, linen, leather, &c.

In paper cases, which are for the generality most made use of, it must be observed, 1st, that great care ought to be taken in winding or rolling them upon the roller tight and close; 2d, that the concave stroke be struck clean, smooth, and without large wrinkles; and 3d, that each sort of cases be of an equal length and size.

The rocket-shells being very tiresome for two persons to make by hand, a machine has been invented for the easement thereof. It is made of an oaken board about two feet wide and three or four inches thick, planed, smoothed, and cut out into channels or grooves of different sizes, to serve for greater or lesser rockets, and is commonly called the saddle. To these sort of saddles are also made pressers, whereby the cases on the roller are pressed down with a heavy hand. The handle of the roller, having a hole in the middle, a small iron bar is put in; and as the man presses with one hand, he turns the roller with the other; and by this means the paper is brought as tight as it ought to be. (See fig. 5. and 6.)

For four and six pound shells it is to be observed, that each sheet of paper (except the first and last, in the part where the neck is formed) is to be a little moistened.

The necks of rockets may be formed several ways. For those of three quarters of a pound, a well-twisted packthread will do; which having one end tied to a stick, and put between one's legs, and the other to a post, will draw it close with ease. The large shells require more strength; one end of a strong cord being fastened to a post, and the other to the belt with a hook, as in fig. 7.; and this by main force draws the cord twisted about the neck of the case.

Some make use of a bench, on one end whereof is fixed a post, to which a cord is fixed, and conveyed

over a pulley, and through a hole in the bench, to a treddle, to which it is fastened, whereby the necks are forced very tight. The necks of extraordinary large sized rockets are forced with strong cords over screws, and round neck irons, proportioned to the size of the shell.

The wooden, tin, and pasteboard rockets are supplied with necks, turned of wood, joined and fastened through the sides of the shell with wooden pegs.

How to prepare the Charges for Rockets, and order the Fires thereof to be of various Colours.

BEFORE you begin to charge the shell of the rocket, be very careful that the powder is well worked and cleaned; that the saltpetre is thoroughly refined, and made into an impalpable powder; that the brimstone be well cleansed and brought to the highest perfection; that the coals be of lime-tree, or other soft wood, well burned, powdered, dried, and sifted; and that all these ingredients be well mixed together, and searced through a fine sieve.

When you are satisfied in these things, and have weighed the proportionable quantities of each, put the mixture into the work-board (fig. 8.), and grind it therein with the grinder (fig. 9.), for an hour together; then try your charge, by sifting a little on a table; and if, when lighted, it burns away in an even fire, and does not fly up, it is a sign that it is worked enough; but if at one place it burns quicker than another, or doth stop its course, then you must grind it more. The charge being thus prepared, you must put it up safe in a moderate place, that it is neither too hot, cold, nor damp, in a box or other dry vessel; and when you charge your rocket, then sprinkle and mix the charge with a little brandy.

Having rammed a rocket for trial, fire it in a secure open place. If it mounts even and high, and gives a report as soon as it turns, it is a sign of being

made to perfection; but if the rocket burst as soon as it is lighted, then the charge is too fierce; or if it rises a little, and falls back, then the charge is foul and weak. The former is rectified by adding more charcoal, and the latter by some meal powder. For the rest it must be observed, that the larger the rockets are, the weaker must be the charge; and on the contrary, the smaller they are, the stronger must be their charge.

If you would represent a fiery rain falling from the rockets, mix among your charge a composition of powdered glass, filings of iron, and saw dust. This shower is commonly called the peacock's tail, on account of the various colours that appear in it.

You may also exhibit a variety of colours issuing forth from a rocket, by mixing among the charge a quantity of camphire, which produces a white or pale fire; rosin, a red and copper colour; bloodstone, which has been nealed and beaten to a palpable powder, will yield a blood red; sulphur, a blue; sal armoniac, a green; raw antimony, a reddish or honey colour; ivory shavings, shining silver; filed agate stone, an orange; and pitch, a dark and deep-coloured fire. This must be managed with discretion; and practice will be the best teacher in that particular, for long lessons are more fit to perplex a young beginner than put him forwards.

The charges are commonly divided into three sorts or degrees, *viz.* in white, grey, and black. I have, the better to guide beginners in this art, set down several sorts of charges, according to the proportion of rockets, but without distinguishing the three several colours; wherefore you have to observe, that to the grey charges are four ingredients, *viz.* meal powder, saltpetre, charcoal, and brimstone; to the white charges, three ingredients, *viz.* saltpetre, brimstone, and charcoal; and to the black charges, two, *viz.* meal powder and charcoal.

Charges for Land-swarmers, or small Rockets.

Meal powder, 1 lb. charcoal, 1 oz.—Or,

Meal powder, 5 oz. charcoal, $\frac{1}{2}$ oz.

Meal powder, 15 oz. charcoal, 2 oz.

Meal powder, 6 oz. saltpetre, 4 oz. brimstone, 1 oz. charcoal, $1\frac{3}{4}$ oz.—This last may be used for the fusée of others.

Charges for Water Rockets.

Saltpetre, 2 oz. brimstone, $\frac{1}{2}$ oz. charcoal, $1\frac{1}{2}$ oz.

Meal powder, $1\frac{1}{2}$ lb. saltpetre, 4 lb. brimstone, 2 lb. charcoal, 5 oz.

Meal powder, 4 oz. saltpetre, 1 lb. brimstone, 8 oz. charcoal, 1 oz.

Saltpetre, 2 oz. brimstone, $\frac{1}{2}$ oz. charcoal, $\frac{1}{2}$ oz.

A general Charge for Rockets of two or three Ounces.

Meal powder, 12 oz. saltpetre, 2 oz. brimstone, $\frac{1}{2}$ oz. charcoal, $1\frac{1}{2}$ oz.

Charges for Rockets of four, five, and six Ounces.

Powder, 15 oz. saltpetre, 12 oz. brimstone, $1\frac{1}{2}$ oz. charcoal, 4 oz.

Powder, $1\frac{1}{2}$ lb. saltpetre, $1\frac{1}{2}$ lb. brimstone $10\frac{1}{2}$ oz. charcoal, 12 oz.

Powder, 2 lb. saltpetre, 1 lb. brimstone, 3 oz. charcoal, $14\frac{1}{2}$ oz.

Powder, 8 lb. saltpetre, 12 lb. brimstone, 2 lb. charcoal, 4 lb.

Powder, 12 oz. saltpetre, 2 oz. brimstone, 2 oz. charcoal, 2 oz.

Saltpetre, 4 lb. brimstone, 14 oz. charcoal, 1 lb.

Powder, 3 oz. saltpetre, $\frac{1}{2}$ oz. brimstone, $\frac{1}{2}$ oz. charcoal, $\frac{1}{2}$ oz.

Powder, $1\frac{1}{2}$ lb. charcoal, $3\frac{3}{4}$ oz

For eight, nine, and twelve Ounce Rockets.

Meal powder, 18 lb. saltpetre, 8 lb. brimstone, 1 lb. charcoal, 4 lb.

Powder, 4 lb. saltpetre, $3\frac{1}{2}$ lb. brimstone, 15 oz. charcoal, 1 lb. 4 oz.

Powder, 3 lb. saltpetre, 2 lb. brimstone, 2 lb. charcoal, 1 lb.

Powder, 3 lb. saltpetre, 2 lb. brimstone, 1 oz. charcoal, 1 lb.

Powder, 9 lb. charcoal, 1 lb. 8 oz.

Saltpetre, 2 lb. 4 oz. brimstone, 8 oz. charcoal, 14 oz. antimony, 4 oz.

Saltpetre, 1 lb. 2 oz. brimstone, 2 oz. charcoal, 4 oz.

Saltpetre, $10\frac{1}{2}$ oz. brimstone, 1 oz. charcoal, 3 oz. brass file-dust, $\frac{1}{2}$ oz.

Saltpetre, 2 lb. 4 oz. brimst. 8 oz. charc. 14 oz.

For one, and one and a half Pound Rockets.

Meal powder, 3 lb. saltpetre, 4 oz. brimstone, 1 oz. charcoal, $4\frac{1}{2}$ oz.

Powder, 32 lb. brimstone, 2 lb. charcoal, 6 lb.

Powder, 2 lb. saltpetre, $2\frac{1}{2}$ lb. brimstone, 12 oz. charcoal, 1 lb. 3 oz.

Powder, $6\frac{1}{2}$ lb. charcoal, 1 lb.

Powder, 3 lb. saltpetre, 15 oz. brimstone, 4 oz. charcoal, $7\frac{1}{2}$ oz.

Powder, 4 lb. saltpetre, 1 lb. 8 oz. brimstone, 10 oz. charcoal, 1 lb. 12 oz.

Powder, 2 lb. saltpetre, 1 lb. 4 oz. brimstone, 1 oz. charcoal, $8\frac{1}{2}$ oz.

For two and three Pound Rockets.

Meal powder, 3 lb. 8 oz. saltpetre, 3 lb. 10 oz. brimstone, 1 lb. 4 oz. charcoal, 1 lb. 3 oz.

Saltpetre, 4 lb. 8 oz. brimstone, 1 lb. 8 oz. charcoal, 1 lb. 4 oz.

Saltpetre, 60 lb. brimstone, 2 lb. charcoal, 15 lb.

Powder, 2 lb. 13 oz. saltpetre, 15 oz. brimstone, 4 oz. charcoal, $7\frac{1}{2}$ oz.

Powder, 12 oz. saltpetre, 1 lb. 8 oz. brimstone, 6 oz. charcoal, 6 oz.

Powder, 4 lb. saltpetre, 9 oz. brimstone, $3\frac{1}{2}$ oz.
charcoal, $10\frac{1}{2}$ oz.

Powder, 1 lb. saltpetre, 8 oz. brimstone, 2 oz. charcoal, 3 oz.

Powder, 11 lb. charcoal, 2 lb. 10 oz.

Saltpetre, 6 lb. 4 oz. brimstone, 1 lb. charcoal, $2\frac{1}{2}$ lb.

For four and five Pound Rockets.

Meal powder, 6 lb. saltpetre, 4 lb. brimstone,
 $1\frac{1}{2}$ lb. charcoal, 2 lb. 6 oz.—Or,

Saltpetre, 64 lb. brimstone, 8 lb. charcoal, 8 lb.

For six, eight, or nine Pounders.

Meal powder, $12\frac{3}{4}$ lb. saltpetre, 6 lb. brimstone,
 $2\frac{1}{2}$ lb. charcoal, $5\frac{1}{2}$ lb.—Or,

Saltpetre, 35 lb. brimstone, 5 lb. charcoal, 10 lb.

Meal powder, $22\frac{1}{2}$ lb. charcoal, 5 lb. 12 oz.

Meal powder, 1 lb. saltpetre, $\frac{1}{2}$ lb. brimstone,
2 oz. charcoal, 3 oz.

Saltpetre, 9 lb. brimstone, 1 lb. 9 oz. charcoal,
 $3\frac{1}{2}$ lb.

For ten and twelve Pounders.

Saltpetre, 62 lb. brimstone, 9 lb. charcoal, 20 lb.

Powder, 11 lb. saltpetre, 7 lb. brimstone, 3 lb.
charcoal, 6 lb.

For fourteen, fifteen, and sixteen Pounders.

Powder, $10\frac{1}{2}$ lb. brimstone, $9\frac{3}{4}$ lb. charcoal, 7 lb.

Saltpetre, 23 lb. brimstone, 8 lb. charcoal, 16 lb.

For eighteen, or twenty Pounders.

Powder, 22 lb. saltpetre, 16 lb. brimstone, 7 lb.
charcoal, $13\frac{1}{2}$ lb.

Saltpetre, 24 lb. brimstone, 12 lb. charcoal, 26 lb.

For thirty, forty, and fifty Pounders.

Powder, 8 lb. saltpetre, 16 lb. brimstone, 2 lb.
charcoal, 4 lb.

Saltpetre, 30 lb. brimstone, 7 lb. charcoal, 18 lb.

For sixty, eighty, and a hundred Pounds.

Saltpetre, 36 lb. brimstone, 10 lb. charcoal, 18 lb.

Saltpetre, 50 lb. brimstone, 20 lb. charcoal, 30 lb.

To bore the Rockets, or ram them over the Piercer.

SINCE the boring of rockets is one of the principal things belonging to them, for their operating well, the bores are to be made in proportion to the size of the rockets; for some of them are bored tapering to a point; others are hollowed square, running also to a point; and others are rammed over a round piercer, which is fixed in the wart of the rocket mould (see fig. 1, I.), and stands perpendicular, running tapering to a point. The stronger the charge of the rockets, the narrower should be the bore; and the weaker the charge, the deeper and wider; for if a strong charge is bored too deep, it will break in ascending; and if it is bored too little, and the charge too slow, it will fall to the ground without any effect; they are commonly, in middling charges, bored two thirds of the tube from the neck.

The boring must be performed strait and even; and although some will give themselves the trouble to bore them by hand, it is better, when a quantity is to be bored, to send them to a turner.

The rockets should be bored but a few days before they are to be used, and kept in dry places; which you must also observe in other materials for fireworks.

For Garnishing of Rockets.

THIS is done several ways, for they may be both within and without furnished with crackers. On the outside it is done in the following manner, viz. that end of the rocket which is solid, is divided into three equal parts, and then bored in the middle of each, quite to the charge. At the bottom of these holes

paste a ring of thin paper; upon which sling some meal powder; then fix in the crackers, stuffing the sides with some tow or flax; and over that paste a covering of paper, to close the opening between the rocket and crackers.

The inside is finished thus.—Put a small round board (in which you have bored several holes) upon the charge; then strew meal powder in them, and fix your crackers, cover it with a cap, and paste it to the outside of the rocket.

You may also furnish rockets both within and without with sparks, stars, and fire-rain, when these materials are joined either within or without. You may also fix to the large rockets, swarmers, by boring a touch-hole in both, filling them with meal powder; and after the touch-holes are exactly fixed one on another, glue them together with a bandage of paper. Thus you may mark a winding figure with a thread on a rocket, and place your swarmers accordingly. (See fig. 10.) You may also, instead of swarmers, place a globe on the top of the rocket, charged with the composition of rockets, and filled with crackers. This globe must have a touch-hole, and be lighted before the rocket is let off, and it will have a good effect. Several other things may be done that way, as the genius of every virtuoso in the practice thereof will direct him. (See fig. 11, 12.)

How to proportion the Rocket-poles and Sticks.

It is common to tie but one rocket to a stick, but six or seven may be placed round the thick end thereof, which must be worked with grooves, as you see fig. 13. But as no rocket would ascend high, if it were not for the true balance observed in the pole or stick, you must further observe, that those sticks are made of light, dry, and strait wood, and must (to one and two pound rockets) be seven times as

long as the rocket; which proportion of the small ones of seven diameters must also be observed in the larger sort; that end where the rocket is tied to, must be two-fifths, and below, one-sixth of the diameter thereof. It is best to give the turner an unbored rocket and one that is bored, thereby not only to measure the length, but also balance the weight. After the rocket is tied to the stick, take it four inches from the neck of that rocket not yet bored; and from the neck of the bored one, about two or three fingers, so as to stand on the back of a knife or one's finger, in an equilibrium. In large rockets the poles must be eight or nine rockets long; and to find their balance, you take their libration twelve inches from the neck.

Rockets without Sticks.

THERE are also rockets made without sticks. Fix to the small ones, from four to eight, nine or ten ounces (after they are bored and rammed), four wings, in the nature of arrow feathers, made either of light wood or pasteboard, which are glued cross-ways to the rocket. Their length must be two-thirds, and the breadth below, one-sixth of the rocket; the thickness may be one-eighth of the diameter. (See fig. 14.) These sort of rockets are fired on a board or stand, placed between four small sticks, as you see in fig. 15.

Others fasten one end of a wire, which is about a foot long, twisted like a screw, to the mouth of the rocket, and hang an iron ball to the other end, of an equal weight with the rocket. (See fig. 16.)

Of Girandel Chests, how and with what the Rockets are fired therein.

THE girandel chest is made of wood, of what size you think proper, according to the number of rockets you design to fire at once.

The method of firing these rockets is performed several ways. Some fill the necks of them with meal powder, others with quick match; wherewith, or with gun-match, they fire them. The best way to light the girandel, or other fire-works, is a match prepared on purpose in the following manner:

Cut some slips of paper of the length of half a sheet, and about one or two inches wide; roll and glue each of them together over a little round and smooth stick of a quarter of an inch thick. This done, take it off when dry, and fill it with the composition hereafter mentioned, ramming it in by little and little with a less stick than that upon which you rolled the shell. These sort of matches are put upon pointed pinchers; and when they are lighted, cannot be extinguished by either rain or wind.

The Composition.

Meal powder, $3\frac{1}{2}$ oz. saltpetre, 7 oz. brimstone, $3\frac{3}{4}$ oz. moistened with linseed oil.

Meal powder, 1 lb. saltpetre, 1 lb. brimstone, 13 oz. moistened with linseed oil.

Meal powder, 1 lb. saltpetre, 1 lb. 4 oz. brimstone, 4 oz. charcoal, 2 oz. rosin, $2\frac{1}{2}$ oz. moistened with turpentine and linseed oil, and worked well together.

Meal powder, 12 oz. saltpetre, 2 oz. brimstone, $3\frac{1}{2}$ oz. charcoal, $1\frac{1}{2}$ oz. turpentine, 1 oz. tallow, $3\frac{1}{4}$ oz.—First, melt the turpentine and tallow together; then stir the other ingredients among it, and pour it in the paper shells; when dry, they are fit for use.

Of Rockets that run upon Lines, or Ropes, from one Place to another.

THESE are made several and different ways; and to give them the more show, some garnish them with figures of various devices.

The first sort is contrived by fixing two iron rings, or a wooden tube, to a rocket, filled with a certain quantity of a suitable composition, and bored as usual. Through these rings, or tubes, is put a line, on which the rocket is to run. This is of the most simple kind; for being arrived at the place where the duration of its combustible matter will allow it to reach, it there stops. This sort is represented in fig. 17.

For the second sort, fill any rocket, whose orifice is equal to that of the former, but much longer, to the height of four diameters; bore it to the depth of three and a half. Upon this composition put a cap or little wooden partition, without any hole through it. Glue this to the inside of the rocket, or secure it any other way to prevent the fire, when arrived to that place, from catching hold of the composition contained in the other part of the case. This done, charge the remainder of the rocket to the same height as before, namely, to four diameters; and three and a half must be bored. After this, choak the rocket at top, and make a little receptacle for the priming, as at the other end; or else fit a round piece of wood to it, with a hole through the middle, as you see in A, fig. 18, which you cover with a little cap. To this add on one side a tube made of a very thin iron plate, which fill with meal powder. Then bore a hole through the side of the rocket, near the other side of the partition that is in the middle, and fill it with meal powder. This is done to convey the fire through the tube to the receptacle A, where it lights the other rocket, and consequently obliges it to return back to the place from whence it came; the upper part, which holds the priming, must be covered with paper, as well as the small tube that conveys the fire from that to the other end. This rocket must also have two iron rings, or a wooden tube, to run along the line. You may make the di-

version the greater, by tying small paper crackers all round. The contrivance of this rocket is very pretty. You have the representation in fig. 18, 19.

The decorations and devices that are usually fixed to these running rockets, may be either flying dragons, pigeons, Mercurys, Cupids, or any other fancy.

Charges for the Line Rockets.

Meal powder, 3 oz. saltpetre, $1\frac{1}{2}$ oz. and charcoal, 3 oz. will be a right proportion for three, four, or six ounce rockets.

Meal powder, 8 oz. saltpetre, 2 oz. brimstone, $\frac{1}{2}$ oz. charcoal, 1 oz.

Meal powder, 9 oz. saltpetre, 1 oz. brimstone, $\frac{3}{4}$ oz. charcoal, 4 oz.

Meal powder, 14 oz. saltpetre, 7 oz. brimstone, 2 oz. charcoal, 4 oz.

These charges may be used for sixteen and twenty-four pounders.

Meal powder, 1 lb. saltpetre, $\frac{1}{2}$ lb. brimstone, 3 oz. charcoal, 5 oz.—This charge is proper for three-quarters and one pound line rockets.

It will be advisable to make some trials of the charges, that you may be sure of not failing in the performance. (See fig. 17, 18, 19, where *a* is the rocket, *b* the tube (or, instead thereof, some rings that slide upon the cord), *c* the partition, *d* the pipe for the communication of the fire from one rocket to another.)

How to join two Rockets to one another, the one to burn in the Water, and the other to fly up into the Air.

TAKE two rocket-shells of equal dimensions; fill one with a good charge quite full; the other charge, bore, and tie to a stick, as usual. The former you glew upside down with a little glew to the middle of the latter, and toward the end tie it round with a

cord that is somewhat longer than the rocket-stick; to the end thereof fasten a ring, and in that a leaden ball, which is to keep both rockets in a due position on the surface of the water; through this ring put the end of the stick, which is provided with a cross that is somewhat wider than the diameter of the ring, and keeps the cord, ring, and ball under water: the communication of the fire must be made below the rockets, by a small pipe, filled with meal powder very secure, so as to keep it from the water; for as soon as the water rocket is burned to the end, the fire will make its way through the pipe, and the land rocket will disengage itself by its force from the case of the other, and leave the cord, ring, and ball behind in the water. (See fig. 20.)

How to make Water Rockets, Water Brands, Water Cats, Water Ducks, &c. that turn themselves in the Water.

THE cases for the water brands, and also their sticks, must be made somewhat longer than ordinary, and be filled with a composition of coarse coal-dust, small rubbed tanner's bark, or sawdust, but in the same method as sky rockets. The whole case is to be 9 or 10 diameters long, and must be divided into 5 equal parts, and be charged two-fifths full of composition; upon this charge a report of a quarter high, and upon that fine iron flakes, in order to sink it; then cover it with paper, and draw it together with a cord. The charge is lifted up a little in the neck, and supplied with brandy dough, or meal powder moistened with brandy; then glewed over with paper; and having fixed a wooden swimmer below the neck, it is dipped in wax and pitch, and is then ready.

Water crackers, which turn in the water, are thus prepared.

This case is made nine or ten diameters long, the neck is drawn quite close, and charged with meal powder almost half full; upon this a partition is made with a hole in it; then put corned powder for a report. Upon that is placed another partition; the rest is filled with meal powder, the end tied close, and the paper cut short at both ends. When these crackers are to be fired, make a touch-hole at the end of both, reversed. Having filled them up with meal powder, and covered them well with brandy-dough, you may fire and fling them into the water, having before dipped them in melted wax or pitch.

It is to be observed, that to the water cat cases, one may proceed thus from one ounce to half pound crackers; but if larger, they are too heavy, and will not so soon turn up again in the water, till some parts of them are consumed. Wherefore, to remedy this, put in the case first three measures of charge; upon this put a little corn powder; then again two measures of charge, and a little corn powder; and proceed thus as far as the report. Upon the charge is placed a partition of wood with a hole in it; on that a report of good corn powder; then tie it close. Further, open it a little, putting some meal powder mixed with brandy to it; and when you would use it, anoint it all over with either grease or linseed oil. The water crackers, or divers, are commonly rammed at one, one and a half, or two ounce cases, stratified in the manner just mentioned, taking two measures for each lay of water cat charge, and a little corn powder between each.

There are other sorts of rockets, that may be represented swimming on the water. These are made in the same manner as the one or one and a half ounce rockets; bored one-third in the charge, then put into a paper cylinder with two small wooden heads, or basis, having a hole bored to the center of each. The height of this cylinder must be equal to

half of the rocket; and the whole, through the centre of each head, fitted exactly to the rocket. When you have fixed every thing to a nicety, put it into melted wax or pitch; and when cold, you may fire and fling it into the water. (See fig. 21, 22, 23.)

You may also put these sort of rockets into a paper case, and fasten it to the neck of the rocket, or else in a bladder full of wind; which, instead of dipping in melted wax, do over with a mixture of four parts of linseed oil, 2 parts of bole armoniac, 1 part of white lead, and half a part of ashes. (See fig. 24, 25.)

You may mix along with the reports of the rockets certain sparks and stars intermixed with meal and corn powder. To this is fixed an iron or wooden tube; from each end of this goes another smaller tube, all having communication with one another; also, with the composition, add the stars, &c. These are filled with meal powder, covered over with paper dipped in wax or pitch; and the counterpoise being fixed below, it is fired. As soon as the composition is burned down to the cap, it is conveyed through the small tubes to the lower part; where beating out the partition, it disperses the powder, stars, &c. to the air.

Charges for Water Rockets.

Meal powder, 6 oz. rosin, 1 oz. charcoal, $\frac{3}{4}$ oz.
Saltpetre, 1 oz. corn powder, 1 oz.

Saltpetre, 1 lb. brimstone, 8 oz. meal powder,
8 oz. charcoal, $4\frac{1}{2}$ oz.

Saltpetre, 4 oz. brimstone, 3 oz. charcoal, $\frac{3}{4}$ oz.

Meal powder, $1\frac{1}{2}$ lb. saltpetre, $\frac{1}{2}$ lb. brimstone,
 $4\frac{1}{2}$ oz. charcoal, 6 oz. coarse coal, $2\frac{1}{2}$ oz. and lead
for sinking, 1 oz.

Meal powder, 2 lb. saltpetre, 1 lb. brimstone,
10 oz. charcoal, 8 oz. coarse coal, 3 oz. sinking lead,
 $1\frac{3}{4}$ oz. for three-quarter ounce rockets.

Meal powder, 2 lb. saltpetre, 2 lb. brimstone,

1 lb. charcoal, 4 oz. coarse coal, 3 oz. tanner's dust, $2\frac{1}{2}$ oz. sawdust, 2 oz. glass powder, 1 oz. sinking lead, $1\frac{3}{4}$ oz. for one pound rockets.

Meal powder, $\frac{1}{2}$ lb. saltpetre, $\frac{3}{4}$ lb. charcoal, 5 oz. sawdust, $\frac{1}{2}$ oz. and $\frac{1}{4}$ oz. fine chopped cotton, boiled in saltpetre lee.

Charges for Water Crackers.

Meal powder, $2\frac{1}{2}$ lb. saltpetre, $1\frac{1}{2}$ lb. brimstone, 10 oz. charcoal, 11 oz. coarse coals, 9 oz. The sinking is, to two ounce crackers, $\frac{1}{4}$ oz. of lead.

Meal powder, $2\frac{1}{2}$ lb. saltpetre, $2\frac{1}{2}$ lb. brimstone, 1 lb. 5 oz. sawdust, 12 oz. charcoal, $\frac{3}{4}$ lb. coarse coals, $\frac{1}{2}$ lb. the sinking, $\frac{1}{4}$ oz.

Meal powder, 4 oz. saltpetre, 5 lb. brimstone, $2\frac{3}{4}$ lb. tanner's dust, $1\frac{1}{2}$ lb. charcoal, 1 lb. coarse coals, $2\frac{3}{4}$ lb. glass dust, 4 oz. lead $\frac{3}{4}$ oz.

Charges for Tumbling Water Crackers.

Meal powder, 1 lb. saltpetre, 1 oz. charcoal, $1\frac{1}{2}$ oz.

Meal powder, 1 lb. saltpetre, 8 oz. brimstone, $\frac{3}{4}$ oz. charcoal, $1\frac{3}{4}$ oz.

Meal powder, $\frac{3}{4}$ lb. charcoal, 4 oz. for one and a half, or two pound rockets.

Charges for Water Cats.

Meal powder, 2 parts; saltpetre, 4 parts; brimstone, 1 part; coarse coals, 2 parts; sawdust, 2 parts; antimony, 3 parts, moistened with linseed oil.

Meal powder, $2\frac{1}{2}$ oz. saltpetre, $3\frac{1}{2}$ oz. antimony, $\frac{1}{2}$ oz.

Meal powder, 1 lb. saltpetre, 2 lb. brimstone, 1 lb. and charcoal, 1 lb.

Saltpetre, 15 oz. brimstone, 5 oz. sawdust, 8 oz. antimony, 2 oz.

Some General Remarks upon Rockets.

1. Your rockets must have their proportionable height, according to the diameters of their orifices.

2. Their necks must be drawn or choked firm; and to prevent the cord giving way, they must be glewed over.

3. Prepare your composition just before you want it.

4. Let it be neither too damp nor too dry, but sprinkle it over with a little oily substance, or a little brandy.

5. When you drive your rockets, put always equal quantities of composition in your cases at a time.

6. Carry with your mallet an even and perpendicular stroke, when you charge your rockets.

7. The cavity must be bored upright and perpendicular, exactly in the middle of the composition.

8. Bore your rockets just before you use them; then handle them carefully, lest their form should be spoiled.

9. Let the sticks and rods be well proportioned, strait, and smooth.

10. Put your rockets, when completed, in a place that is neither very damp nor dry.

11. Let most of your rockets have at top a conic figure; by that means they will the easier shoot through the air.

12. Avoid, if possible, a damp, foggy, rainy, or windy night, to play your rockets.

Defective Rockets are chiefly discovered by the following Observations.

1. When they are fired, and in mounting two or three perches they break and disperse, without performing their proper effects.

2. When they remain suspended on the nail, and waste away slowly, without rising at all.
3. When they form an arch in their ascent, or a semicircle, and return to the ground before their composition is burned out.
4. When they mount in a winding posture, without an uniform motion.
5. When they move on slowly and heavily.
6. When the cases remain on the nails, and the composition rises and disperses in the air.

More of these vexatious accidents will sometimes frustrate the hopes of a young practitioner; but as the above are the principal ones, he must endeavour to avoid them in his first beginning.

Of Rocket Flyers, and the Manner of charging them.

THESE are of two sorts, namely, the single and double. The latter are made after the following manner:—

Have a nave or button turned, the dimension of three inches, together with two knots upon it, perpendicular one against the other, of an inch and a half long, and so thick that both rocket cases may fit over them. There must be also a hole of the third of an inch in the centre of the nave, for the iron pin to go through, on which it is to fly. After this, take two rocket cases of equal dimensions, which are choked quite close at the neck, and glewed; ram in the charge so far as to leave only room to fix them on the two knobs upon the nave. This done, bore into both rockets, near the closed-up necks, small touch-holes; and one more near the pin, in that which is to burn first. From this hole, carry a little pipe to the hole near the neck of the other rocket, having first filled it with meal powder, that when the rocket is almost burnt out, the second may be lighted by the first. The three touch-holes

stand in one row; and you may, on the other side, fix a couple of reports, which will cause a swifter motion.

The single flyers are made with more ease. The neck in these must not be tied close as in the former, but they must be fired in that place. But these do not turn so well as those that are made double. The figures hereof will give you a fuller idea how to manage them. (See fig. 26. 27.)

Of Fire Wheels.

Of these there are three sorts, viz. single, double, and triple. Some of their fells are of a circular form, others an hexagon, octagon, or decagon form; some like a star without fells; some, and the most of them, are made to run perpendicular to the earth; others, horizontal. All may be ordered so as to serve either on land or water.

The fire wheels that are to be used on land, turn upon an iron pin or bolt, drawn or screwed into a post. The nave is turned of close and firm wood; in which the joiners glew the spokes, according to the number of the fells, which must be carefully joined together; then have a groove hollowed round, so deep that the rocket or case may be about half lodged therein. (See fig. 28.)

The double wheels must have their fells turned stronger and wider, with a groove for the rockets, not only at top, but also on one side thereof; plying the necks of the rockets at top to the right, and those of the sides to the left hand. (See fig. 29.)

A triple wheel has a groove at top, and one at each side. The matches are laid from one groove and rocket to another with small pipes filled with meal powder. You may also make a triple wheel on a long nave, and observe the placing of the rockets on each, contrary one to the other; and the commu-

nication you are to make with small pipes; which, after they are fixed, you are to cover and glew over with paper. (See fig. 30.)

Your rockets being ready, and cut behind a little shelving, bore them; the first, three diameters of its orifice; the second, two and three-fourths; the third, two and a quarter; the fourth, two diameters; the fifth, one and three-fourths; the sixth, one and a half; the seventh, one and a quarter; the eighth, one diameter; always the latter something shorter than the preceding. After this, they are primed with meal powder worked up with brandy, and, when dry, glewed in the above described grooves. You must bear the first fired rockets neck up above the rest, underlaying it with a tin plate, or any thing else. The same you must observe in the head of the last fired one, wherein you put the charge of a report. You may also glew on every end of the rockets, a report of paper, with small pipes of copper, or goose quills, which are fixed one end in the side of the rocket, and the other in the report. When all is dry, then you may cover your wheel on one or both sides with linen or paper, in what form you would have it.

The horizontal wheels are made like the others with fells, or out of one entire piece; their grooves are furnished with rockets, and their plane garnished with crackers. (See fig. 31.)

A fire wheel, which is to whirl horizontally in the water must be thus ordered:—

Take a pretty large wooden dish or bowl, that has a broad flat rim; (see fig. 32.) also a smooth dry board, something larger than the dish, and formed into an octagon. In the middle of this board make a round hole that will hold a water ball, so that one half be received in the dish, and the other half rise above the surface of the board. Nail this board upon the rim of the dish, and fix the ball in

the middle, tying it fast with wire; then glew your rockets in the grooves which are made round the edges of the board, laying them close to one another, so that successively taking fire from one another, they may keep the wheel in an equal rotation. You may add, if you please, on each side of the wheel, a few boxes filled with crackers or cartouches erected perpendicular, and also fix double and single crackers, following in a range one after another for two or three fires, or as many as the extent of the wheel will admit.

For your private fuzees, observe that you conduct one from the rocket, which is to be fixed to the composition of the ball in a channel.

Fill these channels with meal powder, and cover them close with paper; lay also a train of fuzees of communication from the rockets to a cartouch, and from that to the rest.

Lastly, when all is ready and covered, dip the whole machine into melted pitch, and secure it from the injury of the water; the ball is fired first; and when lighted, you place it gently on the surface of the water, and then fire the rocket.

To try a fire wheel, first weigh one of the rockets, tie it to a fell with cord; and according to that weight, fill little long bags full of sand, tying them likewise on the rest of the fells; then hang the wheel on an iron pin, and fire the rocket. If it turns the wheel, then you may assure yourself it will be complete when finished.

Wheels formed like stars are to have their spokes fixed upright in the nave, like other wheels, only with grooves on one of the sides of each, where you glew the rockets. At the bottom of each rocket is made a little hole, from whence the fire is conveyed through little pipes filled with meal powder up to the next, and so round; then cover it with linen

cloth, or paper, in the shape of a star, and place it on the iron axis.

Observe, that all rockets used in fire wheels have their necks tied close, leaving only a small conveyance from one rocket to another. The last of all must be well secured below, where you may place a strong report of corn powder.

Charges for Fire Flyers and Wheels, of four, five, and six Ounce Rockets.

Meal powder, 3 lb. saltpetre, 2 lb. charcoal, 5 oz. and sea-coal, 3 oz.

Meal powder, 14 oz. saltpetre, 6 oz. charcoal, 3 $\frac{1}{2}$ oz. brimstone, 3 oz. sea-coal, 3 oz.

Meal powder, 15 oz. saltpetre, 6 oz. brimstone, 3 oz. and charcoal 3 oz.

Saltpetre, 5 lb. brimstone, $\frac{3}{4}$ lb. charcoal, 1 lb. 4 oz.

These charges are bored a little with a round bodkin.

Meal powder, 2 lb. sea-coal, 8 oz. charc. 10 oz.

Meal powder, 3 lb. brimstone, 8 oz. charc. 10 oz.

These charges may be used for triple wheels, and must be bored one third with a bodkin.

For Wheels of one Pound Rockets.

Meal powder, 6 lb. saltpetre, 3 lb. brimstone, 1 lb. 7 oz. charcoal, 2 lb. 9 oz. tanner's dust, 1 oz.

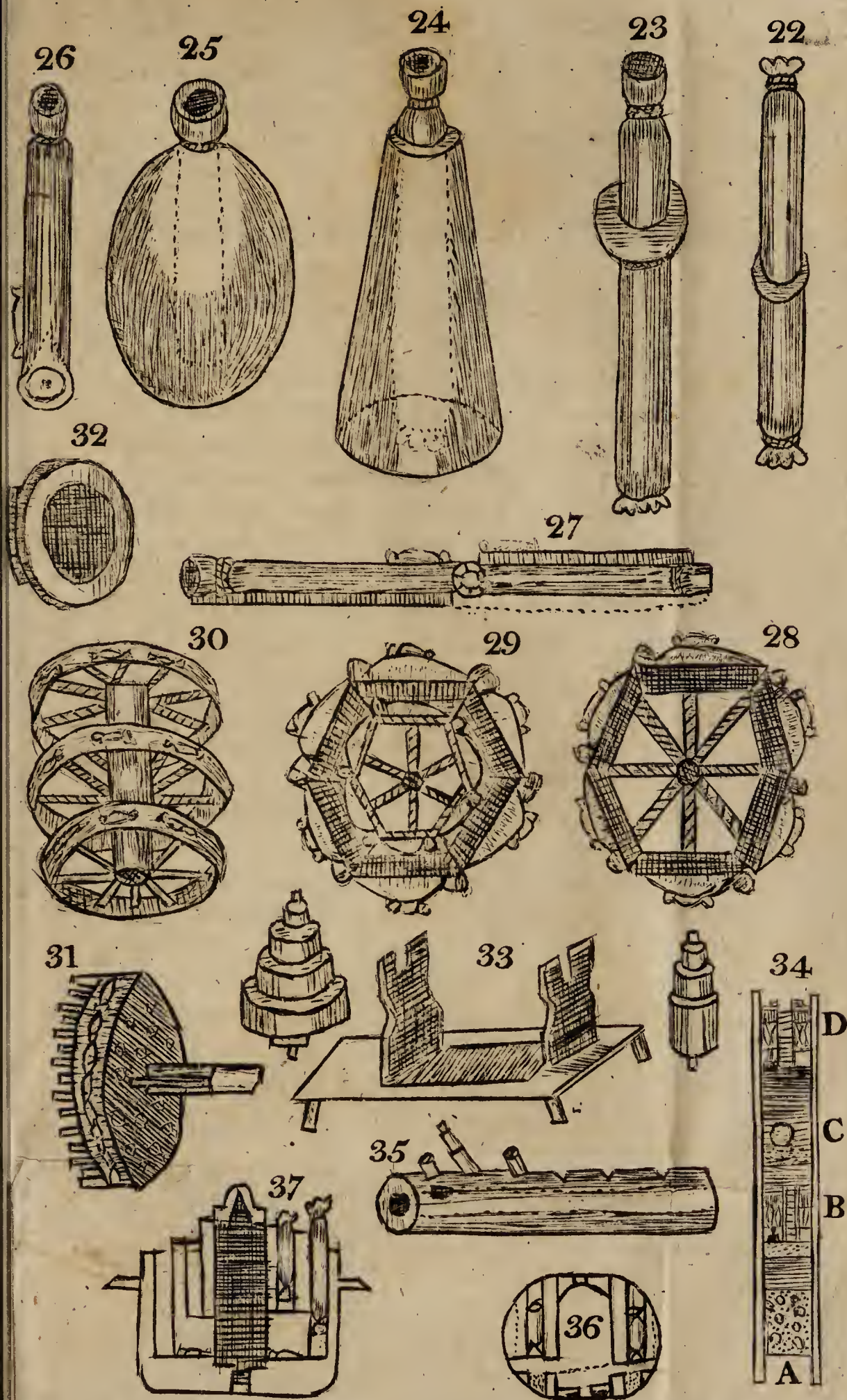
The bore must be an inch and a half.

For Wheels of one-and-a-half and two Pound Rockets.

Meal powder, 6 lb. saltpetre, 3 $\frac{1}{2}$ lb. brimstone, 1 $\frac{1}{2}$ lb. charcoal, 2 $\frac{3}{4}$ lb. sawdust, 1 $\frac{1}{2}$ oz.

The first rocket in the wheel is in length two diameters and a half of its orifice.

Plate 2.



For Wheels of three and four Pound Rockets.

Meal powder, 9 lb. salpetre, $1\frac{1}{2}$ lb. brimstone,
1 lb. 2 oz. charcoal, 3 lb. 4 oz.

The first rocket is bored but one and a half of its diameter.

To make single and double Cartouches or Boxes, Tubes, Stars, Sparks, &c.

WHEN some hundred boxes or cartouches are adjusted and fixed in machines of great fire-works, they afford among the towering rockets great delight to the spectators. These boxes are made either of wood, pasteboard, or copper; and are charged and proportioned, according to their strength, with the charge and composition that is designed for them. If made of wood they must fit exactly, and receive each other, so as to seem but one continual piece; and if pasteboard, you must glew on a foot at bottom, of a hand high, to each of them. The inside of these machines must exactly fit and correspond with the outside of the cartouches themselves, and be so contrived as to slip into one another.

The engine (fig. 33.) is very proper for the construction of those boxes. One represents the bench, and the other the cylinders; upon which (having first greased them over with soap), fashion your boxes just as you think proper, by pasting one thickness of paper upon another, and fixing a handle to the end of the cylinder.

Having formed them, put them to dry in a moderate heat; too great a heat will shrivel them up. When dry, take one after another off the cylinder, and immediately clap round wooden bottoms; the edges being first done over with glew, into them, and sprig them on the outside to make them secure.

The single boxes are to be charged in the following manner:

1. Put in some corn powder.

2. Upon that charge fix a round pasteboard, well fitted to the concave side of the box, which has five or six small holes, and is on both sides laid over with meal powder tempered with brandy.

3. Put upon the pasteboard a little meal powder, and upon that well pierced crackers, so as to stand with their necks downwards; the principal rocket is put in the middle, with the neck downwards, open at both ends; so that being lighted above, and burning down, it may fire the rest of the crackers, which are blown up in the air by the corn powder.

4. The empty spaces between the large fire-case and the crackers are carefully filled up, and the cartouch is stuffed at top with tow, or else with sawdust boiled in saltpetre lee.

5. The cartouch is covered with a cap, which is glewed very closely thereon; and for the great case reaching out of the cartouch, make in the middle of the cap a hole, through which it is put, and close the opening by glewing some slips of paper round it. The fire-case is loose, covered with a pasteboard cap.

Double Boxes or Cartouches.

To enlarge on the description of double boxes, seems to be entirely needless. Only observe, that the bottoms of the upper boxes serve for the covers of the lower, a hole being made, through which the lower box of the composition is fired, after the upper rocket has forced away the empty box, which has already discharged its load. The upper box you cover, as has been shown above. If there are more than two cartouches upon one another, they are called the Burning Tubes, which, when fired, shorten by degrees, the cartouches following one another till all are fired. Some are intermixed with

artificial globes, and several other fancies, which afford great pleasure to the spectators.

These boxes, or cartouches, are placed in long cases made for that purpose. The vacancies about the cartouches may be filled up with sand.

Another Sort of Fire Tubes

ARE made of solid, hard, and dry wood, of what height and thickness you think proper; bore the middle of the wood one-third or one-fourth of its diameter; after which divide the whole height into equal parts, each exactly corresponding with the sky-rockets you design to fix upon them, but rather a small matter shorter; all these divisions are cut sloping downwards, except the uppermost, which must run out in a cylinder. On the rims of each of these divisions make a groove all round, of about a finger's breadth. In these grooves bore small holes, by which the fire may be conveyed through pipes from the cavity of the tube, to light the rockets that stand behind the paper cartouches, which must be made secure to the wood, lest they should fly up along with the rockets.

The construction of the hollow tube in this and other such like tubes is represented in fig. 34. A, the fire stars and sparks, intermixed with corn powder. B, a box filled with paper or crackers. C, a fire-ball, or water globe, which of them you please. D, another box filled with crackers. The hollows between these fires are filled up with corn powder, to blow up the globes and boxes one after another.

The stars and sparks made use of on this occasion are prepared in the following manner:

Beaten saltpetre, $5\frac{1}{2}$ lb. meal powder, 2 lb. 4 oz. brimstone, 1 lb. 12 oz.

Meal powder, 3 lb. saltpetre, 6 lb. brimstone, 1 lb. camphire, $\frac{1}{2}$ oz. tanner's bark, 2 oz. or else sawdust; all finely sifted and moistened with linseed-oil.

Meal powder, 1 lb. saltpetre, 4 lb. brimstone, $\frac{1}{2}$ lb. pounded glass, 6 oz. moistened with linseed oil.

Saltpetre, $\frac{1}{2}$ lb. brimstone, 2 oz. antimony, 1 oz. meal powder, 3 oz.

Saltpetre, $\frac{1}{2}$ lb. brimstone, 3 oz. antimony, 1 oz. iron file dust, $\frac{1}{2}$ oz.

Saltpetre, 2 lb. meal powder, 10 lb. brimst. 1 lb.

Saltpetre, 1 lb. brimstone, $\frac{1}{2}$ lb. meal powder, 3 oz. antimony, 1 oz.

Saltpetre, 1 lb. sulphur, 2 oz. powder of yellow amber, 1 oz. crude antimony, 1 oz. meal powder, 3 oz.

Sulphur, $2\frac{1}{2}$ oz. saltpetre, 6 oz. fine meal powder, 5 oz. frankincense in drops, mastick, mercury sublimed, each 4 oz. white amber, camphire, each 1 oz. antimony, orpiment, each $\frac{1}{2}$ oz.

These ingredients being well beaten, and searced through a searcer, must be sprinkled over with a little glew or gum water, and formed into little balls of the bigness of a small nut, then dried in the sun, or near a fire, and laid up in a dry place, to be ready, on occasion, for playing off with fire-works. When you use them, wrap them up in tow.

Sparks are prepared thus.

Saltpetre, 1 oz. ditto melted, $\frac{1}{2}$ oz. meal powder, $\frac{1}{2}$ oz. camphire, 2 oz.

Having melted these things by themselves (when you use them), put them together in an earthen pot, pour on them water of gum tragacant, or brandy that has gum arabic or gum tragacant dissolved in it, that the whole may have the consistence of a pretty thick liquid. This done, take one ounce of lint, which before has been boiled in brandy, vinegar, or saltpetre; when dry, throw it into the composition; mix it, and stir it about, till it has soaked it up; then roll them up in pills about the bigness of

great pins heads, and set them to dry, having first sprinkled them with meal powder.

Single Tubes, or Cases,

ARE only filled with compositions, and to the outside are fastened some crackets, serpents, or cartouches. These cases being generally round and uniform, like a cylinder, you are to trace out a winding line from the top to the bottom, on which cut holes to the depth of two or three inches. (See fig. 35.) Into these holes contrive to fix paper cases with wooden bottoms, wherein you may put any sort of rockets you please; but take care you provide little holes, to lead from the great tube to the corn powder under these rockets.

Charges for Cartouches, or Boxes.

Meal powder, 6 oz. saltpetre, 1 lb. 8 oz. brimstone, 4 oz. charcoal, $4\frac{1}{2}$ oz.

Meal powder, 14 oz. saltpetre, 5 oz. brimstone, 2 oz. charcoal, 3 oz.

Meal powder, 1 lb. saltpetre, $\frac{3}{4}$ lb. brimstone, $4\frac{1}{2}$ oz. tanner's bark, or sawdust, 2 oz. charc. 4 oz.

Charges for Fire Tubes.

Meal powder, 6 lb. saltpetre, 4 lb. charcoal, 2 lb. rosin, $\frac{1}{2}$ lb. tanner's bark, 5 oz. moistened with a little linseed oil.

Meal powder, $\frac{3}{4}$ lb. saltpetre, 4 lb. brimstone, 10 oz. sawdust, 4 oz.—This charge must be used dry.

Meal powder, 5 lb. saltpetre, 3 lb. charcoal, 1 lb. 6 oz. rosin, $\frac{3}{4}$ lb. not moistened.

A Preservative for Wood against Fire.

TAKE brick dust, ashes, and iron filings, of each an equal part; put them together in a pot, pour glew water, or size, upon it; then put it near the

fire; and when warm, stir it together. With this size wash over your wood work; and when dry, repeat it, and it will be proof against fire.

To prepare a Globe which burns like a Star, and leaps about both on Land and Water.

CAUSE a globe to be turned of dry wood, whose diameter is the length of a half pound or pound rocket. Divide this globe into two equal parts; in the middle of one of the half globes, in the inside, make a cavity, deep, long, and wide enough to hold three or four rockets or crackers, so that the other half of the globe may be easily and closely fitted upon them. After this, take three crackers, one with strong reports, and two without any. Place them so into the hollow, that the head of the one may lay to the other's neck, and be so ordered, that as soon as the one is spent, the other may take fire and force the globe back; and thus alternately from one to the other till it comes to the report, which finishes. Care must be taken that the fire passes not from the first to the next cracker before it has quite consumed the first; but as I have given a caution in the article about rockets that run on a cord, the same may be observed here.

Having taken care to fix the rockets, cover them with the other half globe, and join them firmly with strong pasted paper.

To prepare Light Balls.

Crude antimony, 2 lb. brimstone, 4 lb. rosin, 4 lb. coal, 4 lb. pitch, $\frac{1}{2}$ lb.

Having powdered all these ingredients, put them into a kettle or glazed earthen pan, over a coal fire, and let it melt; then throw as much hemp or flax into it as may be sufficient to soak it up; then take it off the fire; and while it is cooling, form it into balls. You may wrap them up in tow, and put them into rockets or globes.

To prepare the Paste for Stars and Sparks.

Meal powder, $5\frac{1}{2}$ oz. brimstone, 1 lb. 12 oz. Or,
 Meal powder, 3 lb. saltpetre, 6 lb. brimstone,
 1 lb. camphire, 2 lb. tanner's bark, or sawdust, 2 oz.
 Moisten all these ingredients with linseed oil.

Meal powder, 1 lb. saltpetre, 4 lb. brimstone,
 $\frac{1}{2}$ lb. powdered glass, 6 oz. moistened with a little
 linseed oil.

Saltpetre, $\frac{1}{2}$ lb. brimstone, 2 oz. antimony, 1 oz.
 meal powder, 3 oz.

Saltpetre, $\frac{1}{2}$ lb. brimstone, 3 oz. antimony, 1 oz.
 iron file dust, $\frac{1}{2}$ oz.

Saltpetre, 2 lb. meal powder, 10 lb. brimst. 1 lb.

Saltpetre, 1 lb. brimstone, $\frac{1}{2}$ lb. meal powder,
 3 oz. antimony, 1 oz.

Having mixed and prepared your ingredients,
 boil some flax in saltpetre lee and camphire; then
 cut it small, and mix it up with any of the above
 compositions, which must be moistened with either
 the white of eggs, gum, or size. Form this into
 little balls of the size of a hazel nut, strew them
 over with meal powder, and let them dry.

To cause the stars to burn very bright, make your
 composition thus:

Saltpetre, $1\frac{3}{4}$ oz. brimstone, $\frac{3}{4}$ oz. powder, $\frac{1}{4}$ oz.

Saltpetre, 2 lb. brimstone, $14\frac{1}{2}$ lb. meal powder,
 6 oz.

To prepare Water Globes with single or double ascending Rockets.

FOR the first sort, have a globe turned with a tube
 in the middle, half its diameter wide, leaving two
 inches for the placing of solid wood at the bottom;
 round this tube bore holes for small rockets there-
 on; after which, burn, with a red hot wire or small
 iron, touch-holes out of the large tubes into the lit-

the ones ; then fill the globe with the following composition :

Saltpetre, 2 lb. brimstone, 8 oz. meal powder, 8 oz. sawdust, 12 oz.

This done, close the top with a stopple which has a touch-hole in the middle ; then put a good deal of meal powder in the small tubes up to the touch-holes ; and after you have placed your rockets upon that, fill the vacancy round with a little corn powder ; glew over them paper caps ; then dip the globe into pitch, but not over the paper covering ; fix a counterpoise at bottom ; and when the fire has burned half way or further in the large tube, it will communicate through the touch-holes, and discharge all the rockets at once.

The second sort is done after the same manner, only the middle tube is not bored so wide, because of giving more room for two rows of small tubes round it ; the first row next to the tube is bored a little below the middle, the second almost near the end ; the touch-holes for the former are burned from the inside of the great tube, and those of the latter from the outside hole are closed again with a wooden pin ; in the large tube you may lodge a strong report of iron, charged with corn powder, having a touch-hole at top. (See fig. 36, 37.)

Charges for single Water Globes.

Corn powder, $\frac{1}{2}$ lb. saltpetre, 16 lb. brimstone, 4 lb. ivory shavings, 4 oz. sawdust, boiled in saltpetre lee, 4 lb.

Meal powder, 1 lb. saltpetre, 6 lb. brimstone, 3 lb. iron filings, 2 lb. rosin, $\frac{1}{2}$ lb.

Meal powder, 4 lb. saltpetre, 24 lb. brimstone, 12 lb. sawdust, 8 lb. powdered glass, $\frac{1}{2}$ lb. camphire, $\frac{1}{2}$ lb.

Corn powder, 1 oz. saltpetre, 12 oz. brimstone, 4 oz. sawdust, 3 oz.

Saltpetre, 12 oz. brimstone, 4 oz. sawdust, 2 oz. melted stuff, $\frac{1}{4}$ lbs. This must be rammed in tight.

Meal powder, 1 lb. 4 oz. saltpetre, 1 lb. 8 oz. brimstone, 9 oz. sawdust, 5 oz. pounded glass, 1 oz. melted stuff, 4 oz. mix them together with a little linseed oil.

Meal powder, 8 oz. saltpetre, 5 lb. brimstone, 2 lb. copper filings, $8\frac{1}{2}$ oz. coarse coal dust, $8\frac{1}{2}$ oz.

Saltpetre, 8 oz. brimstone, 3 oz. sawdust, 1 oz. tanner's bark, 2 oz.

Saltpetre, 6 lb. 12 oz. brimstone, 2 lb. 14 oz. melted stuff, $\frac{1}{2}$ lb. sawdust, 1 lb. coarse coal dust, 1 lb. pounded glass, 1 lb. mixed up and moistened with vinegar.

Saltpetre, 2 lb. 12 oz. brimstone, 2 lb. 6 oz. melted stuff, 4 oz. sawdust, 8 oz. charcoal, $1\frac{1}{2}$ oz. pounded glass, $\frac{3}{4}$ oz. moistened with linseed oil, and mixed up with a little corn powder.

Charges for double Water Globes.

Saltpetre, 4 lb. 6 oz. brimstone, 1 lb. 4 oz. sawdust, $\frac{1}{2}$ lb. coarse coal dust, 6 oz. moistened with a little vinegar or linseed oil.

Meal powder, 1 lb. 4 oz. brimstone, 4 oz. charcoal, 2 oz. moistened with Petroleum oil.

Saltpetre, 3 lb. brimstone, $\frac{1}{4}$ lb. sawdust boiled in saltpetre, 10 oz. moistened a little.

Manner of preparing the Melted Stuff.

MELT 24 lb. of sulphur in a shallow earthen pan, over a clear fire; and as it melts, fling in 16 lb. of saltpetre. Stir them well together with an iron spatula. As soon as they are melted, take it off the fire, and add to it 8 lb. of corn powder. Mix it well together; and being cooled, pour out this composition upon a polished marble or metal plate; and then divide it into pieces about the size of a walnut. This composition is chiefly used for military fire-works;

but for those which are for pleasure, it is distinguished by warm and cold melted stuff, and is prepared in the following manner:

For the first sort; saltpetre, $\frac{1}{2}$ lb. grind among it antimony, $\frac{1}{4}$ lb. till one cannot be distinguished from the other; then melt brimstone, $1\frac{1}{2}$ lb. Put the mixed saltpetre and antimony to it, and mix them well together. This done, put it warm into a wooden mould of two pieces, which should be well greased on the inside. This stuff break afterwards in bigger or lesser pieces. It is, on account of its clear fire, used to imitate stars.

Manner of preparing the cold Melted Stuff.

GRIND the above ingredients; or, meal powder, 8 oz. saltpetre, 4 oz. brimstone, 3 oz. coal dust, 1 oz. together; till all is of one colour. This done, moisten that stuff with the white of eggs, gum water, or size, and make thereof a stiff dough; then strew on a smooth board some meal powder; roll the dough upon that a quarter of an inch thick; strew again meal powder upon it; then cut it into square pieces, and let them dry; or else form small balls of it, the size of a small nut, or larger; then roll them in meal powder, and put them up to dry.

To make a Serpent.

ROLL upon an iron rod, or round stick, some stiff paper, pasting it as you proceed to keep it fast. Introduce the base of the mould into the serpent, and choke it at that place with a packthread greased with a little soap, and tie it afterwards with thread. Then put the mould over the serpent, which thereby is enclosed in it; charging it afterwards, by means of a quill, with the same composition the rockets are made of, filling half the serpent first, and then ramming the charge with the same iron rod the cylinder has been rolled upon; and having put a grain of

vetch over the charge, fill up the serpent with whole powder, leaving a place empty at the top to thrust in a stopple of chewed paper, which must be rammed down with the iron rod. The paper being rammed down, and a little space left empty over it, choke likewise the serpent at that place, and tie it with a thread, as you have done the other end; with this difference, that this end is quite close, and the other has preserved the aperture made to it by the spike thrust into it at first. This empty place is primed afterwards with gunpowder bruised and mixed with water. Touch paper for making fire-works is made by soaking soft paper in water in which saltpetre is dissolved.

To make a Fire Launce.

TAKE a sheet of large and strong paper; roll it lengthwise upon a rod, the bigness of a musket rammer, and a foot and half long, pasting the paper as before mentioned, to keep it fast; after which is to be introduced into the one end, about an inch far, a piece of wood called the handle or foot of the launce, and of the caliber of the cylinder, having first dipped the wood or stick in paste, that it may be fastened to the cylinder. The other end of the foot is flat, and pierced with two holes, that it may be nailed in any convenient place.

The composition must be, refined saltpetre in powder, 4 oz. gunpowder, 2 oz. likewise pulverised, and passed through a fine sieve; flower of sulphur, 1 oz. The whole mixed, and then passed through a horse-hair sieve. Charge the launce with this composition, ramming with the same rod the cylinder has been rolled upon, in proportion as you charge it; and when it is charged to one-fourth of its height, put as much gunpowder into it as would serve to prime a pistol, which must be rammed gently with the rod without knocking upon it, proceeding in the same

manner till the launce be full to the top. This done, take some beaten gunpowder, and mix it with water to prime it, pasting afterwards a piece of paper over it.

To make a Saucisson.

THE cylinder is to be made four inches long, of a card rolled twice on a round stick, and well pasted. It must be choked at one end at the distance of half an inch from its extremity, and tied with a packthread. A stopple of paper is introduced through the back part of the cylinder into it, by means of the iron rod, wherewith it is rammed tight; after which the cylinder is to be nearly filled with common gunpowder without any preparation; over which is rammed another stopple of paper, choking afterwards and tying the saucisson at that place. This done, it is tied with packthread from one end to the other, so that it may be quite covered with it; then it is thrown into strong glew, and lastly put to dry.

To fasten that saucisson to the launce, you must pierce it with a bodkin at that end which is the best made, till you reach the powder; then take a quill, cut it as if for writing; and having filled the end which is not cut with gunpowder, introduce that same end, thus filled, into the saucisson; and the other end, cut in form of a pen, into the launce, immediately above its foot or handle, where you must make a hole to receive it; and having tied them together at the very same place, cover them with paper in such a manner that the whole be well closed and joined, without hindering the fire from communicating itself from the launce to the saucisson by means of the quill.

For a sky saucisson, make its cylinder four inches and a half high, choke it, and tie it at an inch and a half distance from one of its extremities. Having placed it on the base, charge it with whole powder,

which cover with a stopple of paper, tying it afterwards at that end; then take it off the base, and fill it at several times, ramming it each time with the iron rod, with the same composition used for sky-rockets. When full, take a piece of cord of prime, which is made of cotton, beaten gunpowder, and brandy, so that the mixture of gunpowder and brandy be liquid to stick to the button. As soon as the cotton is dry, take two pieces of it, which place crossways on the end of the faucisson, putting over it some of the composition, and ramming well the whole with the iron rod. By this means come out four ends of the cord of prime, which serves to set fire to the faucisson.

To use this faucisson, you must make a pot six or seven inches high; the diameter thereof must be stronger by a line than the faucisson. This pot must be choked downwards, at an inch distance from the extremity; make afterward a port fire of a playing card, and fill it with the composition of a sky rocket. When charged and rammed, make a button of the diameter of the pot; put one ounce of whole powder into it, and the port fire in the middle, and tie the whole together. Carry the button into the fire pot, the upper end turned downwards, so that it may come through the end which is choked. When you see the end of the port fire come out, tie that choked end of the pot to bind tight the port fire, and through the other end introduce the faucisson, the primed end, where are the four ends of the primed cord, foremost; and the vacuity remaining stopped with paper, with another paper pasted over it.

These pots of sky, or flying faucissons, are commonly disposed on a board or bench, pierced through of the bigness of the port fire, which is introduced into the hole, and glewed, lest the effort of the powder should carry it off; and underneath that board,

the fire is set to each port fire. That port fire, well fastened to the pot, remains fast to the board, and all that was in it flies into the air.

To make Fire Pots.

ROLL some card, or thick paper, two or three times round a piece of wood turned a foot long, and three inches of diameter, pasting it well. Then take off the mould, and thrust into an end of the cylinder another stick, called the foot of the fire pot. This stick must not penetrate the cylinder further than an inch; and then it should be fastened to it with three or four small pegs.

Take a fire launce a foot long, and place it in the middle of the cylinder, so that it may come out by two or three inches; then take it out, and take the mould on which the cylinder has been rolled; on one end thereof fit a sheet of white paper cut in two, and which dispose crossways, to make of it a kind of cap. In the bottom of that cap which has took the form of the pot, put 1 oz. of whole powder, and 2 oz. of the composition used for sky rockets. In the middle of these three ounces of matter place the fire launce abovementioned, and gather round the foot thereof all that matter equally on all sides, keeping it close round the launce with the ends of the paper, which is tied round the launce with packthread; and this is called the button of the launce.

To make Thunder Powder.

THIS is done with three ingredients, namely, three parts saltpetre, two parts salt of tartar, and one part of sulphur: these are pounded, and mixed together. If you take about sixty grains in a spoon, and warm it over a candle or fire, it will give a report like a cannon.

To make an artificial Earthquake.

PROVIDE 18 or 20 lb. of sulphur, and as much of the filings of iron, and make them into the consistence of a paste with common water. This being buried under ground, in eight or ten hours time will vomit flames, and cause the earth to tremble around to a considerable distance. Such is the effect of even two cold bodies in the cold ground, there only wants a sufficient quantity of this mixture to produce a real volcano.

To produce Explosion imitating Gunpowder.

TAKE a phial, which hold reversed the space of a minute over a bottle of dissolution of iron. Take away the phial, and afterwards put a lighted candle to its mouth, and you will see the effects.

N. B.—These explosions are not dangerous.

To imitate Thunder.

TAKE a coarse glass bottle, in which put an ounce of iron filings. Pour in by degrees six ounces of vitriolic acid. Stop the bottle; and after having shaken it the space of a minute, take out the stopper, and bend down the bottle a little. Then present a lighted candle to the mouth, and it will occasion a prodigious noise.

The Manner of preparing Burning Letters and Names for Illuminations.

BURNING letters may be represented after several methods.

Order a joiner to cut capital letters, of what length and breadth you please, about two feet long and three or four inches wide, and an inch and a half thick. Hollow out of the body of the letters, a groove, a quarter of an inch deep, reserving for the edges of the letters a quarter or half an inch of

wood. If you design to have the letters burn with a blue fire, make wicks of cotton or flax, according to the bigness and depth of the grooves in the letters; draw them leisurely through melted brimstone, and place them in the grooves; brush them over with brandy; strew them with meal powder, and again with brandy and thin dissolved gum tragacant, and on that strew meal powder again; when dry, drive small tacks all round the edges of the grooves, and twist small wire to those tacks, that it may cross the letters, and keep the cotton or flax close therein; then lay over it brandy paste; strew over that meal powder, and at last glew a single paper over it.

If you would have the letters burn white, dissolve six pounds of saltpetre, and add to it a little corn powder; in that dip your wicks of cotton or flax.

There is another method for burning letters without grooves, which is done by boring small holes in the letters of about an inch distance one from the other; the diameter of these holes must not be above the eighth of an inch; into them put, and glew cases, rammed with burning charges. These letters do not burn so long as the others, except the charges are very long.

Another method is used, when the letters are formed by a smith, of coarse wire, about a quarter of an inch thick. This done, get some cotton spun into match thread, but not much twisted. To two yards of this take 1 lb. of brimstone, 6 oz. of saltpetre, and 2 oz. of antimony. Melt these ingredients in a kettle, first the brimstone by itself, and then the rest all together. When melted, put in the match-thread, and stir it about till it has drawn in all the matter. Then take it out, and strew it over with meal powder; let it dry, and wind it about the white letters; fasten these upon a board that has been well laid over with a preservative to keep it from firing. When you have lighted one letter,

all the rest of the letters will immediately likewise take fire.

Charges for Burning Letters with Cases.

Meal powder, 6 oz. saltpetre, 1 lb. mixed with Petroleum oil.

Meal powder, $\frac{3}{4}$ lb. saltpetre, 9 oz. brimstone, 3 oz. mixed up dry.

Meal powder, 5 oz. saltpetre, 7 oz. brimstone, 3 oz. file-dust, $\frac{1}{2}$ oz. moistened with linseed oil.

Manner of making Fire burn of a green Colour.

TAKE one part of sal ammoniac, two parts of white pitch, and two parts of verdigrease. Bruise the sal ammoniac and verdigrease to powder; then melt the pitch in an earthen vessel, over a slow fire; put the powder to it, and break the mass which it forms into small pieces. When a little of this is thrown into the fire, it will give it a fine green colour.

Blue fire may be produced, by mixing two parts of blue vitriol with one part of sal ammoniac.

To make Torches which cannot be extinguished either by Wind or Rain.

TAKE old ropes, boil them in saltpetre water, let them dry, and then cover them with sulphur pulverised and coarse gunpowder mixed with brandy. Then take three parts of wax, three parts of pitch, one part of sulphur, half a part of camphire, and half a part of turpentine. Mix these well together, and cover the ropes with it.

To make a Cracker.

THIS is of the most simple construction imaginable. Cut a piece of cartridge paper to the size of about 11 or 12 inches long, and four or five broad. Then fold the paper lengthways about an inch and a

half, and form a trough, into which lay whole gunpowder. Close it very tight, and roll up all the paper over it; then bend it backward and forward into its proper form; prime it with touch paper, and bind it round very firm with packthread.

Odoriferous, or perfumed Water Balls.

HAVE these turned about the size of large wall-nuts, and fill them with the following composition:

Meal powder, 3 oz. saltpetre, 12 oz. frankincense, 1 oz. myrrh, $\frac{1}{2}$ oz. charcoal, 3 oz. mixed with oil of spike. Then light, and put them into water.

Wildfire which burns under Water.

THIS is composed of sulphur, naptha, bitumen, pitch, and gum; and can only be extinguished by vinegar mixed with sand and urine, or by covering it with raw hides.

Chinese Method of embellishing Fireworks with Flowers, &c.

THE only ingredient necessary to produce those flowers is cast iron reduced to sand, which is done by heating small pieces of old cast iron in a forge, and then throwing them into water, where they are left to cool. Thus calcined, the rust falls off in scales, and they are easily reduced into sand. The anvil and hammer used for this purpose must also be of cast iron, because steel flats the grains of sand. It is necessary that the angles of those grains should be sharp, as it is the angles that form the flowers; and according as this sand has passed through sieves more or less fine, the flowers are either larger or smaller.

If the plant which is intended to be represented, has a greater or less quantity of flowers, the sand is in proportion increased or diminished; and the quality of more or less coarse is used in respect of the size of the natural flowers. A yellow, red, or white

colour is given to the fire of those flowers, in imitation of the colour of the flowers of the plant which they represent; and great variety may be introduced by varying the doses of the composition, and changing the quantity and quality of the sand.

The cartouches of these sort of squibs ought to be proportioned to the sand. If the cartouch is of too great or small a diameter, either the sand will not melt, or it will melt before it goes out of the cartouch. Fine sand requires only a moderate fire; but coarse, one that is violent. A cartouch, with an opening of two or three lines diameter, is sufficient for the finest sand; for the sand of the second order, four or five lines; for that of the third order, six or seven lines; for that of the fourth order, nine or ten lines; for that of the fifth order, one inch; and lastly, for the coarsest sand, one inch and a half.

The cartouches of the Chinese squibs, except those of the crackers, are made of a thin paste-board, composed only of two leaves of coarse paper. The pasteboard for the cartouches of the rockets that are fired off before the emperor, is composed of three leaves of paper made of hemp. To prevent accidents of fire, and to keep the cartouches from bursting; in diluting the paste for them, to one pound of flour, they throw in a good handful of sea-salt; and before laying on the fire the flour diluted with salt, they steep some clay to the consistence of thin mud. When the paste is made and taken off the fire, they mix it with nearly as much steeped clay as there is paste, which consequently must make the paste very thin. The whole is well mixed together, being stirred with a stick; the clay keeps the paste-board from catching fire easily, and is therefore less subject to burst; the salt causes the fire that may have caught the pasteboard to be soon extinguished.

The saltpetre, which is an ingredient in the composition of the flowers, ought to be well purified.

All the materials, except the iron sand, must be sifted through a fine silk searce; and they are mixed up with only as much of the strongest brandy as may be thought sufficient to make them granulate. If there be too much brandy, it will cause the flowers to fail. The sand is first humected, and afterwards mixed with the sulphur; then the saltpetre is added, the charcoal, and the other materials that are sometimes ingredients for diversifying the colours of the fire.

The cartouches are charged as those of rockets. The match is placed half out of the cartouch; and this half, for greater security against fire, is wrapt up in a bit of paper that reaches beyond it, but is twisted only about the match where it enters the squib.

To contain those squibs when they are fired off, it is sufficient to put them between two bricks laid flat. It would be advisable to raise them a little, especially when the composition has not much force, that the flowers may all appear before the sand falls to the ground.

The materials for forming raisins, or bunches of grapes, in the Chinese fireworks, is nothing else than sulphur reduced into an impalpable powder, of which a paste of a pretty hard consistence is made with that of flour. With this paste they garnish letters made of strong iron wire, that the matter may the more easily hold, which will remain on fire as long as one pleases, in proportion to the quantity of matter employed therein. That all may take fire at the same time, a match is applied about the figures; and besides the matches, the whole is wrapped up in paper, which, in catching fire, communicates it an instant every where.

F I N I S.

